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FOREIGN TECHNOLOGY DIVISION

TECHNOLOGY OF AIRCRAFT CONSTRUCTION

(Selected Chapters)

by

A.L. Abibov, N.M. Biryukov, et al.

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

TECHNOLOGY OF AIRCRAFT CONSTRUCTION.

A. L. Abibov, N. M. Biryukov, V. V. Boytsov, V. P. Grigoryev, S. V. Yeliseyev, [deceased], I. A. Zernov, L. A. Konorov, P. F. Chudarev.

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Chapter XXIII.

MANUFACTURE AND ASSEMBLY OF SECTIONS AND AGGREGATES FROM NONMETALLIC MATERIALS.

§1. Characteristic and the field of application of reinforced plastics.

During manufacture of large-size sections and aggregates/units from nonmetallic materials in aircraft construction predominantly reinforced plastics, which are composite materials, are used. They consist of different polymers - bonding agents with the reinforcing elements introduced in them.

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For reinforcement of plastics are utilized diverse filaments - organic, metallic, asbestos, glass, quartz, siliceous, ceramic, and also other materials.

Widest application in structural reinforced plastics finds glass fiber and obtained on its basis woven and nontissue reinforcing materials. The glass fiber with a diameter of from 3 to 12-15 μ, obtained by drawing from molten of glass mass, inherited from the initial material (glass) a comparatively low density, good dielectric properties, nonflammability, chemical inertness, resistance to comparatively high temperatures.

Furthermore, filament in process of drawing obtains higher in comparison with block glass strength, which grows together with improvement of formulas (chemical composition) of glass and technology of drawing.

Thus, for glasses of silicate composition volumetric samples have tensile strength 4-6 kg/mm^2, and filaments with diameter of 4-6 μ - 240-400 kg/mm^2. The modulus of elasticity can vary from 4500 to 9000 kg/mm^2 for the glasses of alkaline and alkali-free (aluminum-borosilicate) compositions respectively. During the introduction to the composition of glass of oxides of beryllium, titanium, zirconium, etc. the modulus of elasticity of glass fibers can reach 10000-12000 kg/mm^2.

200 or 100 monofilaments, extracted from molten of glass mass, which is located in platinum puddle of electrosmelting aggregate/unit, form primary filament, which then undergoes textile treatment/processing. By unwinding, summation and subsequent torsion of primary filaments obtain filaments twisted. Depending on the number of summations (quantity of primary filaments) the thickness of the twisted thread is characterized by its metric number. The number of meters of filament in 1 g is called the number of filament. It is natural that with an increase in the number the thickness of filament is decreased.

Due to heterogeneity of mechanical properties of filaments and difference in their diameters total strength of monofilaments in primary filaments is utilized incompletely. The strength of the twisted thread is reduced additionally as a result of the damages during the textile treatment/processing and composes 50-60% of strength of monofilaments approximately. The elongation of glass filament composes 2.5-3.0%.

In production of sections and aggregates/units from glass-fiber-reinforced plastics following reinforcing materials on basis of glass fiber are utilized.

Nonfabric: primary filament (directly); primary filament into several summations (band); twisted thread; twisted or untwisted filament in the form of unidirectional tape with preliminarily plotted/applied bonding agent; roll bonded materials of continuous or chopped filaments (linens).

Fabrics of three basic weaves: linen or tabby, when longitudinal filaments (basis) are alternated evenly with transverse (weft); sateen, characterized by smaller number of overlaps of basis by filaments of weft; twill, characterized by diagonal arrangement of overlaps of filaments.

Fabrics of linen weave possess greatest density and low flexibility. The fabrics of satin weave possess the highest

flexibility less by the bending of filaments during the treatment/processing and because of this was received preferred propagation in the production of articles made of the fiberglass laminates.

There are other varieties of fiberglass fabrics: reps, hopsack, cord, rarefied and volumetric fabrics and series/row of other, utilized depending on purpose of constructions.

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Second (after glass fiber) in terms of value reinforcing material is asbestos, possessing series of valuable performance properties, high thermal stability, dimensional stability, high rigidity and mechanical strength. The widest use (to 90%) received the soft and flexible filaments of chrysotile, utilized in the form of bands, matte finishes or fabrics. The filaments of chrysotile possess tensile strength 200-250 kg/mm^2 and retain it under the prolonged influence of temperatures of approximately 750-800°C.

Sometimes find use synthetic fibers of organic origin: Anid, Lavsan [лавсан - polyethylene terephthalate film, Soviet equivalent of Dacron], onant, nylon, khlorin, nitron, and also cotton, wool, silk, flaxen, viscose and some others.

For special targets are utilized carbon, beryllium, boron, siliceous, quartz, ceramic, and also single-crystal fibers "whiskers"

from different metals, which ensure stable operation of reinforced materials in constructions, which test/experience very high temperature and power loadings.

Majority of produced fiberglass reinforcing materials is worked by special compositions (dressing), which substantially improve hydrophobic properties (water resistance) of surface of glass fibers.

At present there is large quantity of dressing, which make it possible to improve properties of glass-fiber-reinforced plastics on basis of different bonding agents. Bonding agents are usually the solutions/openings of resins in the organic solvents with the necessary additives for the hardening (by hardeners, by catalysts, by initiators, etc.).

One of first places in production large-size and complicated on form, but not testing/experiencing considerable loads of constructions from reinforced plastics occupy polyester/polyether resins, capable of being solidified over a wide range of temperatures, including with room. Practical value have two classes of resins - polyester maleates - products of the polycondensation usually of maleic anhydride with the dihydric unsaturated acids and polyester acrylates (oligomers), developed in the USSR, the products of the polycondensation of the saturated dibasic acids with glycols in the presence of methacrylic or acrylic acids. Advantages and shortcomings in polyester/polyether resins are well known, and therefore work on an increase in their

thermal stability, the decrease of shrinkage, the elimination of combustibility, reduction in the toxicity, improvement in the technological properties constantly is conducted.

However, for most loaded constructions ever more frequently are used bonding agents on basis of epoxy resin. High adhesion to the fiberglass, low combustibility, chemical stability, sufficiently high mechanical characteristics at normal temperatures made epoxy resins those sufficiently extended in the carrying out of high-strength constructions. The thermal stability of epoxy resins connecting/cementing on basis increases during the modification usually by phenol-formaldehyde resins or compounds, although in this case simultaneously noticeably is decreased the strength of glass-fiber-reinforced plastic as a result of the decrease of adhesion.

For articles of radio engineering designation/purpose, articles, which work at high temperatures, in aero- and thermodynamic flows, phenol and modified phenolic resin are used. The most typical representative of this class is phenol-furfural-formaldehyde bonding agent of brand FN. The bonding agents on the basis of silicon compounds are utilized for the same purposes.

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Thus, by combination of different types of reinforcing materials and polymeric bonding agents it is possible to attain practical

possibility of designing of constructions with prescribed/assigned properties (strength, radiotransparency or radio-absorption, resistance to erosion, chemical stability and series/row of others).

At present in constructions of aircraft and helicopters from glass-fiber-reinforced plastics are manufactured fuselage covering and wings, radomes, air ducts, pressure vessels for compressed gases, fuel tanks, different tanks, blades of propellers of helicopters, cargo containers, etc. For example, tail cone of jet aircraft Boeing-707 is manufactured with pillar from the glass-fiber-reinforced plastic. There are examples of the successful application of a glass-fiber-reinforced plastic in the blades of the propellers of helicopters. These blades/vanes are molded from the oriented in load direction glass fibers with the impregnation with their modified epoxy resin, which, according to foreign data, gives reduction in the weight of blade/vane by 10% and considerable increase in the resource/lifetime. For the English transport aircraft radar fairings from the fiberglass laminate with the grooved filler (Fig. 23.1) are manufactured with the application of melted wax patterns. The channels, which are formed in the filler after the melting of wax patterns, are intended for the circulation of heated air, which removes icing fairing.

There are numerous examples of successful use of glass-fiber-reinforced plastics in constructions of Soviet aircraft and helicopters.

Properties of reinforced plastics to a considerable degree depend on relationship/ratio between connecting/cementing and reinforcing material also of parameters of technological manufacturing process.

With increase in volumetric content of reinforcing material in plastic are raised mechanical characteristics (tensile strength, bending and modulus of elasticity); however, only to certain limit, determined by physicochemical and mechanical interaction of fittings and polymeric bonding agent (Fig. 23.2).

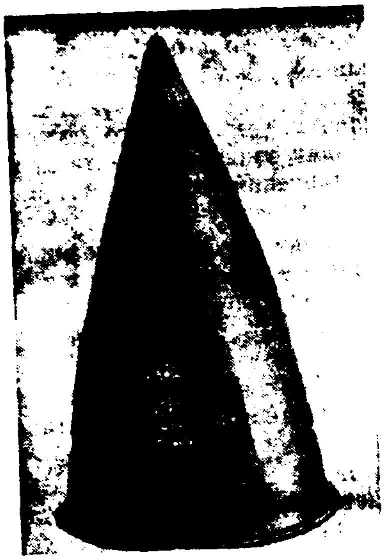

Fig. 23.1

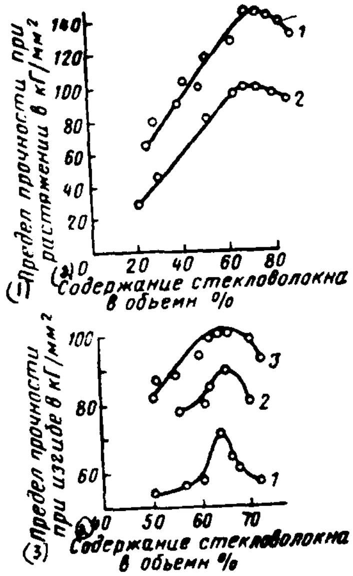

Fig. 23.2.

Fig. 23.1. Fairing with grooved filler.

Fig. 23.2. Change in strength of glass-fiber-reinforced veneer from relative content of fiberglass: 1 - epoxy-phenol; 2 - Butvar-phenol resin; 3 - epoxy-phenol resin with different additives.

Key: (1). Tensile strength in kg/mm². (2). Glass content in vol. %. (3). Transverse strength in kg/mm².

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Depending on the types of the reinforcing material, bonding agent and method of manufacture the limiting values of the degree of reinforcement can vary by the volume from 50 to 85% of content of filaments in the plastic. With respect to this considerably change the mechanical characteristics of material in the construction.

Orientation of reinforcing material is decisive for strength characteristics of construction. The direction of the effective loads must be considered during planning and calculating the construction. The direction of reinforcement or packing of material in the construction must answer the greatest strength of the reinforced plastic, since this type of material possesses the clearly expressed anisotropy of mechanical properties. Consequently, effective only under the condition for the precision determination of the directions of the principal stresses, which affect in the construction, and the respectively precise packing of the reinforcing material in conformity with its polar diagram (dependence of properties on the angle of application of force). The technological limitations of packing material at any preset angle virtually do not exist.

Uniformity of composition and quality of article depends on method of manufacture. As a rule, molding in the closed molds and under the overpressure contributes to obtaining regular and faultless structure.

Temperature parameters of regime/conditions of hardening reinforced plastic affect characteristics of construction in that measure, as this is determined by properties of undersolidified or destroyed bonding agent, and also by residual stresses.

Thus, creation of effective large-size construction from reinforced plastics is almost in each case serious engineering task,

which requires for successful decision of joint labor of designers, technologists and designers to strength.

S2. Methods of manufacturing of sections and aggregates/units.

Let us examine some basic methods of obtaining critical/heavy-duty constructions.

Molding with the aid of hermetically sealed elastic shell. The amalgamated technological process consists of the following basic operations.

1. Surface preparation of form (dummy) by application of antiadhesive lubrication (TsIATIM-201, TsIATIM-221) or packing of sheet tape/film material (for example cellophane) for preventing cementing of article with mold. Depending on what surface of article must be smooth and even/plane, negative or positive molds are used (Fig. 23.2).

2. Packing cutout glass cloth, impregnated connecting/cementing, or dry fabric with subsequent impregnation. Basic requirement during packing of fiberglass fabric is reduced to that so that the edges of the cutout pieces in adjacent layers would not coincide. Under this condition the thickness is retained uniform throughout entire section/cut.

3. Packing separating film (cellophane).

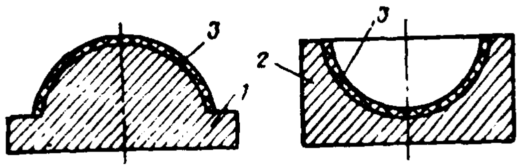

Fig. 23.3. Varieties of forms: 1 - positive; 2 - negative; 3 - molded article.

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4. Packing elastic shell, for example rubber cover, with hermetic sealing/pressurization of flanges by clamping rings and spiral (hydraulic, pneumatic, etc.) clamps.

5. Molding (hardening bonding agent) during prescribed/assigned thermal mode and at overpressure. Overpressure can be created via vacuuming (Fig. 23.4a), in press-chambers (Fig. 23.4b), in the autoclaves and the hydroclaves (Fig. 23.4c). Material in the walls of article becomes denser and more uniform the higher the overpressure. The highest pressure (to 150 kgf/cm^2) can be obtained in the hydroclave.

All these methods most frequently are used in experimental production, since they require minimum expenditures for equipment (dummy), and apparatuses and devices for hardening are general-purpose.

Extrusion/pressing for parts of simplified form and small dimensions, limited to dimensions of working zone of table on press,

is accomplished/realized in molds on hydraulic presses. The thickness of articles is determined by the value of the fixed/recorded clearance between the male die/punch and the matrix/die (Fig. 23.5), a batch of material (in the case of fiber-filled molding materials) or a quantity of layers of fiberglass fabric or fiberglass tape are designated previously.

Depending on properties of molded material unit pressure varies from 50 to 400 kgf/cm^2.

By extrusion/pressing can be obtained articles with smooth surface, by homogenous structure, by high physico mechanical properties.

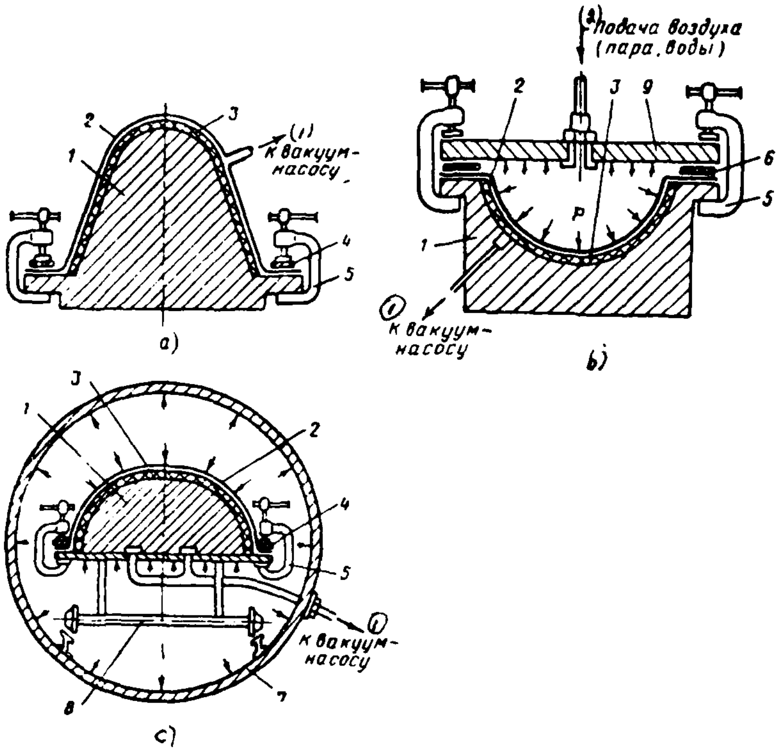

Fig. 23.4. Methods of designing of overpressure: a) by evacuation; b) in shaping bags; c) in autoclaves and hydroclaves (1 - form; 2 - rubber cover, 3 - molded article, 4 - clamping ring, 5 - screw clamp, 6 - elastic packing, 7 - autoclave, 8 - truck, 9 - cover/cap).

Key: (1). To the vacuum pump. (2). Air supply (steam, water).

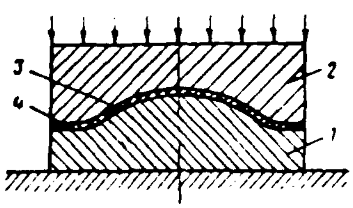

Fig. 23.5. Diagram of extrusion/pressing in rigid die: 1 - male die/punch; 2 - matrix/die; 3 - pressed article; 4 - limiter of clearance.

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Impregnation under pressure [1].

FOOTNOTE [1]. Glass-fiber-reinforced plastics. Collection of articles ed. by F. Morgan. Translated from English. IL, 1961. ENDFOOTNOTE.

This method makes it possible to lay the dry reinforcing material in the form of fiberglass fabric, chopped (50-70 mm) fiberglass, fiberglass fabric, which under the pressure is impregnated with thermoresistant into the form. Pressure is created by vacuuming (Fig. 23.6a) or by the forcing of bonding agent into the form (Fig. 23.6b). Is possible also the combination of vacuuming with the simultaneous forcing, which makes it possible to increase speed and provides the high quality of impregnation.

Essence of method let us examine based on example of manufacture of fairing about radar antenna, schematically depicted in Fig. 23.6a.

To male die/punch 1, which has internal form of article and machined by antiadhesive, is gathered bundle of dry fiberglass fabric, fiberglass fabric or chopped fiberglass of 3 necessary thicknesses. To the bundle is installed matrix/die 2, whose internal cavity is also preliminarily covered/coated with antiadhesive composition. The clearance between the male die/punch and the matrix/die must be equal the wall thickness of article with the necessary tolerance. From small tank 4 under the pressure, created by the vacuuming of the

cavity between the male die/punch and the matrix/die, from the lower part of the form is supplied the bonding agent. By the combination of viscosity, temperature and speed of forcing it is possible to attain a good impregnation of blank with bonding agent.

Bonding agent can be solidified in heating cabinet or by heating directly in installation (vapor, by organic high-boiling liquid, which circulates along special channels in male die/punch) or by built-in into mold electrical heaters.

Advantage of method are precision/accuracy of enclosures of articles, high density of material, imporosity, high degree of airtightness. The process of impregnation can be mechanized, which eliminates the harmful effect of bonding agent on the workers. The expensive complicated equipment is a shortcoming in the method.

Coil/winding. Articles made of the glass-fiber-reinforced plastics, whose form is determined by the rotation of arbitrary generatrices, can be manufactured with coil/winding to the mount/mandrel of the appropriate form of glass filaments, tape or fabric, impregnated with bonding agent.

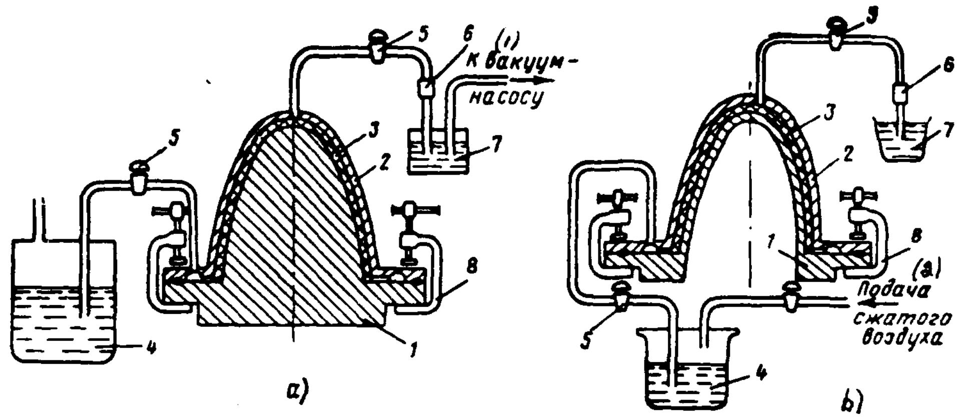

Fig. 23.6. Diagram of impregnation under pressure: a) vacuum (mold, rigid); b) under excess positive pressure [1 - male die/punch, 2 - matrix/die, 3 - filler (fiberglass fabric, fiberglass fabric), 4 - small tank with resin, 5 - stop cock, 6 - inspection window; 7 - small tank for resin, 8 - screw clamp].

Key: (1). To the vacuum pump. (2). Supply of compressed air.

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When oriented-reinforced plastic is packed along trajectories of principal stretching stresses, manufacture of optimum constructions with minimum weight with prescribed/assigned strength is possible.

Fig. 23.7 gives one of possible schematics of so-called turning type spooling machine. Machine tool consists of the drive, which rotates mount/mandrel 7 and moving packer 6. Packer, who carries ring, accomplishes reciprocating motion on guiding 9. The filament with spool 1, impregnated with bonding agent in puddle 3, is passed through the ring. The reinforcing material is packed to the

mount/mandrel under the adjustable tension. The speed of coil/winding depends on the speed of rotation of mount/mandrel. In turn the rotation of mount/mandrel and the displacement/movement of packer are synchronized. Depending on the length of article, calculated winding angle the corresponding numbers of revolutions of mount/mandrel and longitudinal courses of packer are established/installed. Programming connection between the motion of distributor and the rotation of mount/mandrel is most rational. Spooling machines with the numerical system of programmed control found the widest use.

Usually for obtaining material of satisfactory quality it is sufficient pressure, caused by belt tension or filament. In certain cases for obtaining the denser material additional pressing during the heat treatment of bonding agent under the pressure 2-5 kgf/cm^2 is recommended.

At present won acceptance following varieties of method of coil/winding.

Cloth coil/winding, with which to cylindrical or conical arbor in specific sequence are wound layer pre-impregnated (impregnated) fabrics tabby or more frequent than satin weave. It is characterized by high productivity and good airtightness of the obtained article, retained up to its destruction during the testing by internal pressure.

Longitudinal-transverse coil/winding (PPN) (Fig. 23.8a) is characterized by orientation of impregnated tapes, bands on generatrices (longitudinal packing), also, in circular direction at angle of 90° to soy-bean of mount/mandrel (transverse packing). Structural strength is raised in comparison with the cloth coil/winding and is 70-80 kg/mm^2 and it is above.

Spiral, or geodetic, coil/winding (Fig. 23.8b) is accomplished/realized by packing reinforcing material, impregnated with bonding agent, along trajectories of geodetic lines.

Geodetic coil/winding is utilized for manufacturing of conical sections, pressure vessels of spherical, and also cylindrical form with closed ends/faces or polar holes.

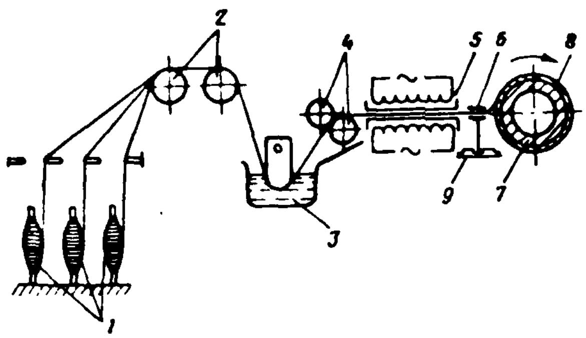

Fig. 23.7. Schematic of spooling machine: 1 - spool; 2 - guide pulleys; 3 - puddle with bonding agent; 4 - squeeze rolls; 5 - heating chamber; 6 - packer; 7 - mount/mandrel; 8 - blank of glass roving, glass filament, glass-fiber-reinforced veneer; 9 - guide of packer.

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In the latter case for obtaining the uniformly strong construction is produced additional coil/winding in the circular direction (fig. 23.8c). Depending on the form of loading to strengthen cylindrical part is possible by additional coil/winding at any angle in the range of 0-90°.

There are other varieties of special coil/winding ("planar"," star-shaped", with variable winding angle, etc.).

Cloth, longitudinal-transverse (PPN) and geodetic coils/winding can it is accomplished/realized by pre-impregnated reinforcing material ("prepregs"), and in this case process is called "dry" coil/winding. Before the packing the prepregs pass through hot rolls

or through the heating chamber and in the softened form they are packed to the mount/mandrel. The coil/winding of the reinforcing material, moistened by bonding agent directly before the packing to the mount/mandrel, is called "wet" coil/winding.

Both these of method have their advantages and shortcomings; however, increasingly more frequently begins to be utilized "dry" coil/winding, which makes it possible to more easily check degree of reinforcement of plastic, also, during coil/winding and hardening more even to distribute filaments and bonding agent along wall thickness, which raises quality of articles. Furthermore, in this case aircraft-construction production can be freed from the preparation of bonding agent and impregnation of the reinforcing material.

For all methods of manufacture of articles made of reinforced plastics examined is very important correct selection and observance of basic parameters of curing process: temperature, pressure and holding time. These three parameters are interconnected.

Heating to specific temperature of glass-fiber-reinforced plastics is necessary for translation/conversion of thermosetting bonding agents into thermostable state (hardening). The heating temperature in the dependence on the type of bonding agent varies within the limits of 150-200°C.

Pressure is necessary for sealing/packing of blank and imparting

to it of precise configuration of article. For most frequently used polyepoxide and nonsaturated polyester/polyether resins, which are solidified without the isolation/liberation of by-products, the pressure depending on the method of manufacture is 1-20 kgf/cm^2.

Holding time is determined by curing rate of bonding agent and wall thickness of construction.

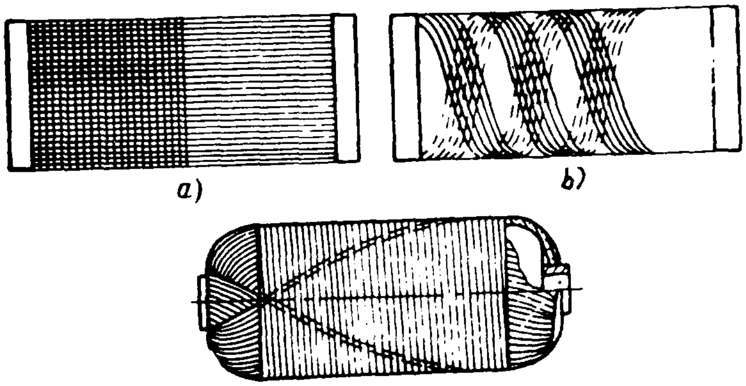

Fig. 23.8. Varieties of methods of coil/winding: a) longitudinal-transverse; b) spiral (oblique); c) transverse spiral.

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In many instances glass-fiber-reinforced plastics are utilized in combination with lungs by fillers in three-layered and multilayer constructions, for example fairings. As the lungs of fillers are used the foam plastics, honeycombed plastics, corrugation, etc.

From foam plastics widest use find polyurethane foams, by which are filled different capacities/capacitances with nonpress method directly on the spot of application.

Honeycombed plastics are manufactured on basis of cotton or glass cloth, by impregnated and glued/cemented synthetic resins. Specific weight, strength and electrical properties of these fillers depend on form and thickness of fabric, sizes/dimensions of cells of hundreds, type of bonding agents, etc. Constructions with light fillers possess

high specific strength, rigidity, satisfactory dielectric constant and thermal stability.

S3. Examples of the manufacture of articles.

Manufacture of multilayer fairings.

Structurally/constructively walls of these fairings are alternation of rigid elements - shells and lungs of fillers and can be three-, five- and seven-layer.

Shells of fairings depending on temperature of their operation are manufactured from fiberglass laminates on basis of epoxy, phenol-formaldehyde, silicon and others bonding agents.

Foam-fins or honeycombs cell from cotton or glass cloth are used as fillers. Fairings with the honeycomb filler possess the best indices of specific strength, good dielectric and thermal insulation properties. Them are manufactured by two methods - with the basing on the internal contour/outline and on the external. The highest precision/accuracy of external enclosures is achieved by assembly with the base for external contour/outline.

Independent of method of basing accepted technological process of manufacture of fairings with honeycomb filler includes preparation of materials for assembly, manufacture of shells and honeycomb filler, assembly and molding of fairing, machining and coloration with system

of per operation and final quality control.

Shells of fairings depending on dimensions and required strength manufacture one of methods described above: vacuuming, autoclave, by impregnation under pressure, coil/winding, etc.

Let us examine basic stages of manufacture of fairing with basing on external contour/outline (here they lower parts, in detail described above).

Inner shell is glued on male die/punch and is solidified bonding agent (Fig. 23.9a). In the matrix/die the outer covering is glued and is solidified bonding agent (Fig. 23.9b). To the outer covering adheres the honeycomb filler of the strictly defined prescribed/assigned thickness (Fig. 23.9c). After appropriate preparation/training the mold is assembled, the lower covering to the honeycombs cell adheres and finally is molded fairing (Fig. 23.9d).

Quality of obtained fairings good, but shortcoming is high cost/value of equipment. Therefore frequently the fairings are manufactured with the basing on the internal contour/outline with the relatively inexpensive equipment.

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Basic stages of this method following:

- to male die/punch (metallic or nonmetallic) is glued lower

covering of required thickness and is produced polymerization (Fig. 23.10a). On the finished lower covering is superimposed honeycomb filler, is produced cementing and polymerization (Fig. 23.10b);

- on the honeycomb filler is glued the outer covering and is performed the final forming of fairing (Fig. 23.10c). The precision/accuracy of external contour/outline is insufficiently high. Outside remain impressions of hundreds, which can be removed by the application of the leveling layer and the paint and varnish coat.

Machining of honeycomb filler before packing of outer covering is performed for purpose of increase in precision/accuracy of external enclosures in certain cases. Device for the machining (Fig. 23.11) consists of two moved pneumatic milling heads, one of which produces roughing and the other - finishing treatment. Heads are moved along the guide rails, fairing itself is rotated on the support/socket, powered by electric motor.

Fig. 23.12 gives general view of fairing with honeycomb filler, in Fig. 23.13 - schematic of basic stages of manufacture of three-layered fairing with polyurethane foam-filler.

Sequence of operations here does not differ from schematic of manufacture of fairing with honeycomb filler examined above by filler with basing in external contour/outline. Drops off only the stage of gluing of hundreds, changed by the filling of semi-finished product (Fig. 23.13a) and by its foaming during the specific thermal mode

(Fig. 23.13d).

Fig. 23.14 gives final stage of molding three-layered radome: excess of foam plastic is drawn off through clearance between male die/punch and matrix/die.

MANUFACTURE OF THE WING TIP OF AIRCRAFT.

Fig. 23.15 gives device for manufacturing wing tip. Molding is produced on positive metal mold of 3, which has the series/row of the deepenings of V-shaped section/cut under the stiffening ribs.

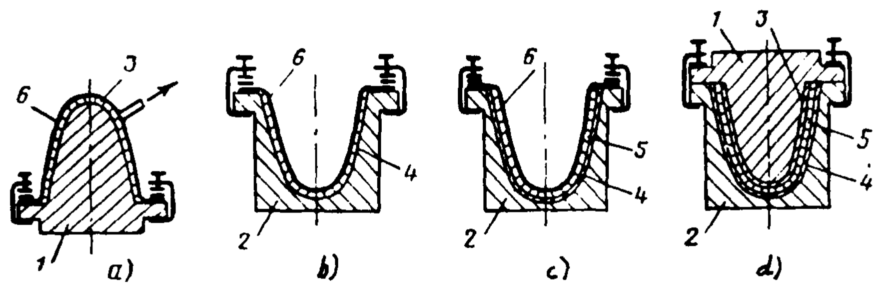

Fig. 23.9. Schematic of basic stages of manufacture of fairing with basing on external contour/outline: a, b, c, d) sequence of stages (1 - male die/punch, 2 - matrix/die, 3 - lower covering, 4 - outer skin, 5 - honeycomb filler, 6 - rubber cover).

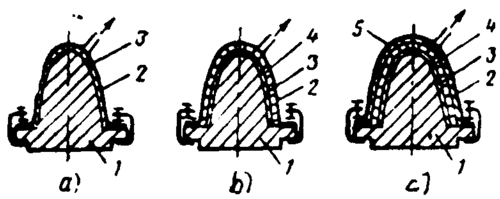

Fig. 23.10. Schematic of manufacture of fairing with basing on internal contour/outline: a, b, c) sequence of stages (1 - dummy, 2 - rubber cover, 3 - lower covering, 4 - honeycomb filler, 5 - outer skin).

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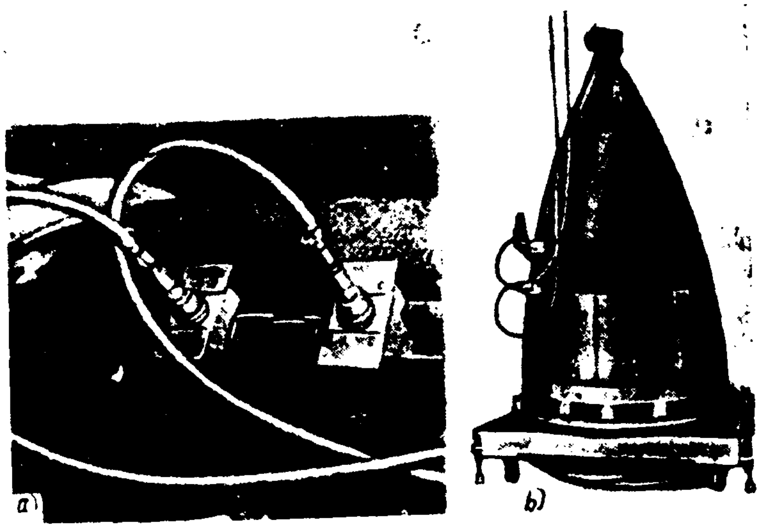

Fig. 23.11. To treatment of light filler of radome: a) pneumatic milling heads; b) general view of milling fixture.

Fig. 23.12. Radome is three-layered construction.

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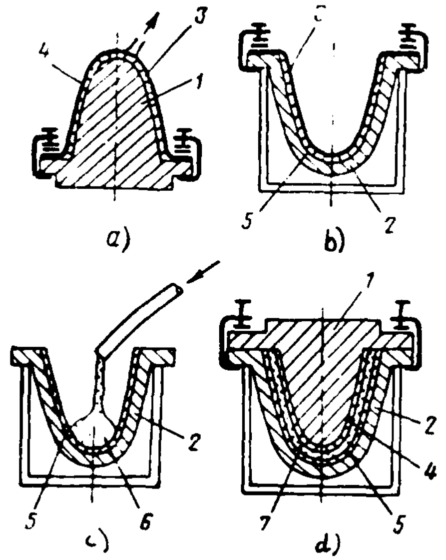

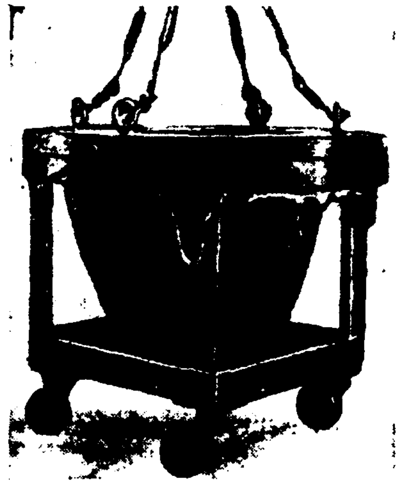

Fig. 23.13. Fig. 23.14.

Fig. 23.13. Schematic of manufacture of three-layered fairing with foam-filler: a, b, c, d) sequence of stages (1 - male die/punch, 2 - matrix/die, 3 - rubber cover, 4 - lower covering, 5 - outer skin, 6 - liquid composition, 7 - foam plastic).

Fig. 23.14. Final stage of molding three-layered radome it is filler from foam plastic.

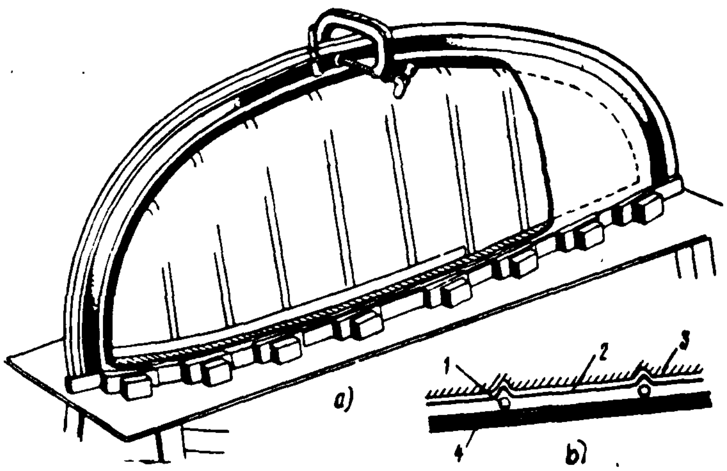

Fig. 23.15.

Fig. 23.15. Device for manufacturing wing tip by method of vacuuming: a) general view; b) section/cut (1 - band, 2 - first layer, 3 - positive mold, 4 - basic part of molded article).

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Let us examine basic stages of manufacture of ending:

- on covered with antiadhesive lubrication form is superimposed one layer of fiberglass fabric impregnated with bonding agent, which is serviced into grooves;

- into grooves are inserted asbestos cord or fiberglass fabric, impregnated with bonding agent;

- before obtaining of necessary thickness is packed additional quantity of layers of fiberglass fabric;

- skin/sheathing is covered with cellophane and rubber cover, which is held in necessary position and is sealed with the aid of metallic frames, clamps and wedges of base/root;

- after vacuum forming article is cleaned, it is checked and is painted.

Fig. 23.16 gives prepared fairing about propeller hub from glass-fiber-reinforced plastic on basis of epoxy resin, obtained by method of extrusion pressing in dismountable mold. Tests showed that similar fairings withstand greater stresses than fairings from any other materials.

§4. Equipment, tooling, tools.

Tooling for manufacture of articles made of glass-fiber-reinforced plastics must satisfy definite requirements:

- molds, dummy, mounts/mandrels (for coil/winding) must be sufficiently strong and rigid in order to prevent strain under effect of vacuuming, overpressure, tension of filaments;

- tooling and equipment must provide uniform heating of entire surface of articles. The surfaces, on which can fall connecting, the glue, foam, must be protected from the cementing by the appropriate lubrications (PVSG, TsIATIM-201, TsIATIM-221, GKZh, etc.);

- construction of tooling must allow packing semi-finished product and indentation (removal) of articles with the minimum expenditure of time.

Aluminum alloys can serve as materials for manufacturing of mounts/mandrels, dummies of molds, steels, rubber, plastics, in particular waste of glass-fiber-reinforced plastics, wood or refined wood, gypsum. The selection of material and constructing/designing the equipment depends on a number of factors, for example the scales of production, dimensions and form of article, method of heating, etc. Equipment can be noncollapsable, dismountable, destroyed (for example from the gypsum or low-melting), and also combined of one or several materials (metal-rubber, metal-gypsum, gypsum-rubber).

Heat treatment can be produced in autoclaves, or heating cabinets, equipped with vacuum systems, compressors and corresponding

measuring and controlling equipment. In the series production the process of heat treatment is automated.

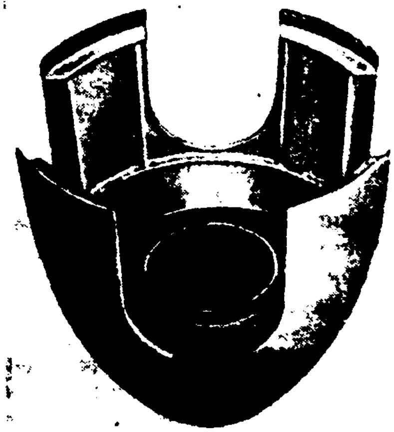

Fig. 23.16. Fairing about propeller hub.

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For heat treatment it is possible to utilize also contact electrical heating elements, built in into appropriate equipment, dry saturated vapor or high-boiling organic heat-carrying agents, for example Ditalylmethane (DTM). In two last cases in the molds and the dummies select the channels, in which lay the conduits/manifolds made of stainless steel. Radiation heating and high-frequency heating sometimes can be successfully used. In the latter case is achieved the most uniform heating throughout entire section/cut of article.

For manufacture of articles by method of coil/winding special winding equipment is used.

§5. Quality control and safety engineering.

Quality control. The guarantee of a high quality of articles made of the glass-fiber-reinforced plastics, manufactured with any method, provides for careful control in all stages of production.

They are subject to control:

- initial materials (filler, bonding agent);
- quality of surface preparation;
- viscosity and consumption of glue and bonding agents;
- quantity of volatile components and resin in reinforcing material;
- correctness of packing impregnated with bonding agent or dry reinforcing material;
- correctness of packing or metering of light filler;
- regimes/conditions of heat treatment.

In finished articles check appearance, form and geometric dimensions, quality of surface (absence of bulgings, cracks, undulation, protruding texture of filament, gaps clearance), strength, while in antenna fairings also radiotransparency, efficiency, gradient and radiation pattern on special phase-meter and other stands.

Special supervisory equipment (for example flaw detector of type IAD-2) makes it possible to reveal quality of cementing (peeling, bubbles). Strength is determined by testing control samples or selectively articles themselves. All articles undergo necessary weight control.

Safety engineering. During the manufacture of articles made of the glass-fiber-reinforced plastics it is necessary to especially strictly observe the safety regulations:

- to the work to allow/assume only those, who passed instruction in safety engineering;

- works to produce only in the presence of supply and exhaust ventilation;

- equipment for the machining must be equipped with special suctions;

- special clothing and the personal clothing of workers they must be stored separately;

- prior to the beginning of work workers are obligated to put on special clothing - connection plate or take, dressing gown from the closely woven cloth with the blind/dead collar and the buttoned sealing rings, gloves. Workers, occupied with machining, furthermore, they must install aprons from the oil cloth, goggles and respirators;

- is forbidden the consumption of food in the location, where works with the fiberglass materials are conducted;

- with outages all open parts of the body (face, hand) must be washed by warm water. At the termination of work to clean special clothing by vacuum cleaner and to accept hot shower;

- connecting is allowed/assumed to make only in the location, which has the effective suction and exhaust ventilation, in special clothing from the closely woven cloth and in the surgical (rubber) gloves.

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Chapter XXIV.

ASSEMBLY WORKS.

S1. Classification and the technological characteristic of aggregates of machinery.

Assembly works encompass assembly and testing of aggregates and units of machinery of aircraft: controls of takeoff and landings, controls of aircraft and of engines, ejection seats, ejectable cockpit hoods of pilot, and also panels and sheet rubber of control of mechanisms.

Machinery of aircraft according to construction-engineering signs/criteria can be divided into four basic groups.

First group compose power hydraulic sets and assemblies of hydro- and of pneumatic systems: shock-absorbing landing gear struts, hydraulic power cylinders, hydraulic dampers, hydraulic drives, reduction, safety, distributive, valves, valves of control of hydro- and pneumatic assemblies, etc. All these assemblies work at large pressures, the high degree of the airtightness of sealings/packings must reliably function in any operational and temperature conditions in the limits, established/installed by technical requirements they are assembled assemblies from the parts, which are tooled with the high precision/accuracy of the combinable sizes/dimensions and the

high trueness of finish. Complete interchangeability is provided by the application of a system of fits, accepted in general machine building. Assembly is fulfilled without any adjustments and does not require special assembly jigs, with exception of the individual cases.

All assemblies of first group pass complete test program before their installation to aircraft on quality-control and testing installations (stands).

Into second group enter such assemblies, as ejection seats, ejectable cockpit hoods of pilot, front/leading and main landing gear, installation of special equipment, etc., represented complicated mechanisms.

Distinctive special features of assemblies indicated are multiplicity of parts and complexity of construction, requirement of high precision/accuracy of assembly and reliability of operation of their mechanisms, which are characterized by speed. All assemblies are connected either with the execution of the most important functions of the systems of aircraft as, for example, takeoff and landing, or they provide the rescue of the life of crew, as ejection seats. The assemblies of this group are collected in the special attachments and require careful control in the process of assembly. Finished assemblies test according to the established/installed program under different temperature conditions.

Third group encompasses mechanisms of control systems of aircraft: foot pedals and control columns, screw mechanisms of flap control, gear reducers, transmission of helicopters, etc. Besides the general requirements of strength, for the assemblies of the third group are presented the requirements of quiet run without the gaps and the reliable functioning under any operating conditions. In the construction of mechanisms the stamped/die-forged and castings and weldments widely are utilized. Majorities of parts and setting places under them in the housings and the weldments are subjected to machining. The requirements of complete interchangeability, observance of mobile and close fits within the limits, established/installed by technical specifications, the guarantees of the prescribed/assigned lengths of courses, angles of rotation and other kinematic parameters are spread to such parts and assemblies.

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In a number of cases these requirements are fulfilled by introduction to the construction of the assemblies of mobile and fixed compensators. Essential is the requirement of interchangeability on the contact surfaces and the attaching holes of those units of mechanisms, on which they are established/installed to the aircraft. The large part of the indicated mechanisms before the installation to the aircraft (helicopter) tests to failure-free performance of action (training) and is passed rolling to different temperature conditions.

Fourth group includes communications centers of mechanical

systems for control: assemblies of rigid rods, intermediate rockers, sectors, boxes of rollers for cables, guide pulleys for rods/thrusts, assemblies of cables with coupling elements, etc. Communications centers must provide the reliable transmission of efforts/forces from the central controls of aircraft and of engines, and also control of the deflection of rudders, ailerons, flaps and timing of the action of the vital assemblies of the aircraft: engines, chassis/landing gear, etc.

For fulfilling of these requirements is produced final regulation of completely assembled systems for control directly on aircraft, for which in construction of units widely are used mobile and fixed compensators. In the connections of the units of control systems for decreasing the friction the antifriction bearings widely are utilized. In a technological respect the assembly of the units of control systems is characterized by the large volume of the bench works: the press fitting of bearings, threading, attachment of tips and sleeves/beakers of the rods by rivets, etc. Brackets for fastening of the rockers and other assemblies must be supplied to the assembly with the finished contact surfaces and with the holes under the fastening bolts and the screws.

§2. Special features of the technological processes of the assembly of the assemblies of machinery.

Sequence of assembly of assemblies of machinery is determined on

the basis of analysis of their construction and technical specifications. First of all is explained the possibility of the separation of assembly per the independent assembly units - the units, which can be assembled from the parts before their connection in the assembly, and then is established/installed the order of the interconnection of the units. With the assembly of units from the parts and the assemblies from the units are determined the methods and the means of achievement of the precision/accuracy of their relative position: by selection, by fitting or by control, with the application of devices or without them and the like.

In technological process are included also operations, connected with testing of correctness of action of assembled mechanisms and tests for airtightness, strength and other parameters, with indication of regimes/conditions and means for accomplishing test program. If after tests assembly for the inspection of parts is dismantled, this also must be reflected in the technological process.

Strictly assembly operations consist in mutual coordination of parts between themselves and connection their method, indicated in drawing.

In series production all parts, supplied to assembly of units and assemblies, must satisfy requirement of complete interchangeability. This allows the significant part of the assemblies of machinery to assemble without assembly jigs, on the basis of the base part (see

Chapter XVI).

In number of cases are used devices, which create conveniences with accomplishing of assembly operations and facilitating labor of workers. As an example Fig. 24.1 gives device for the assembly of shock strut.

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In small-scale production, when increase in precision/accuracy of parts for guaranteeing complete interchangeability with given scale of issuing economically is not justified, with assembly of assemblies and units adjustable works are allowed/assumed. Under these conditions with the assembly of the series/row of assemblies appears the need for special assembly jigs for achievement of the correct relative position of assemblies and parts, entering the assembly, and the required precisions/accuracies of the geometric dimensions of assembly.

Fig. 24.2 as example gives device for assembly of nose wheel strut of landing gear. Assembly is fulfilled in the following order. Are established/installed and fixed in the device by adjusting and clamping elements the shock strut I, braces II, lever of traverse III and traverse IV. All these units are supplied with the preliminarily drilled holes. The final dimension of holes under the coupling bolts in the braces, the ears of traverse and central clamp is obtained by joint countersinking and reaming. The same relates also to the bolt holes, which connect the lever of traverse III with the cylinder shock

absorber V.

Modification of parts with assembly shows imperfection of technological processes of manufacture of parts, low technical level of production, and sometimes shortcomings in constructions of assemblies.

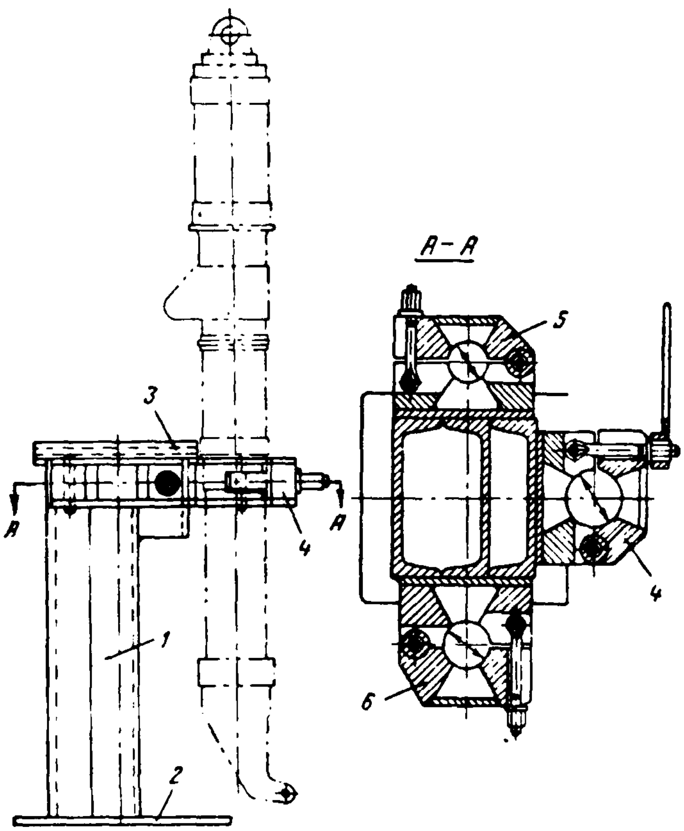

Fig. 24.1. Device (column) for assembly of shock strut and entering it assemblies: 1 - strut; 2 - base/root; 3 - table; 4, 5 and 6 - binding clips of shock strut, stock/rod and diffuser.

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The modification of parts with the assembly is time-consuming, since frequently it is fulfilled under the inconvenient conditions, when the application of mechanized weapons is hindered/hampered. Furthermore, with the fulfillment of adjusting works are required, as a rule, twofold assembly and dismantling of units. After the first assembly the assemblies are dismantled for the measurements, deburring and

shaving and washing of parts. The decrease of the volume of adjusting works on assembly is progressive measure, since this raises labor productivity, it reduces the cycle of assembly, provides the more high quality of assemblies and improves the conditions of the work of fitters.

In assemblies of machinery of aircraft greatest use find bolt, spiral, threaded, slot and press connections.

During development of technological processes creation of bolt and spiral connections it is necessary to indicate sequence of tightening nuts and screws for purpose of guarantee of uniform tightening. Nonuniform tightening can cause elastic deformations, disturb the precision/accuracy of the relative position of parts and assemblies or tightness of connection, which is especially important for pneumo- and hydroaggregates. For these purposes for the constancy of tightening should be utilized the torque wrenches (see Chapter XXI).

Key and splined joints must be fulfilled with established/installed precision/accuracy during machining of parts. Adjusting works require in this case the high expenditures of time. However, under the conditions of small-scale production sometimes resort to the adjustment of loose keys on keyways.

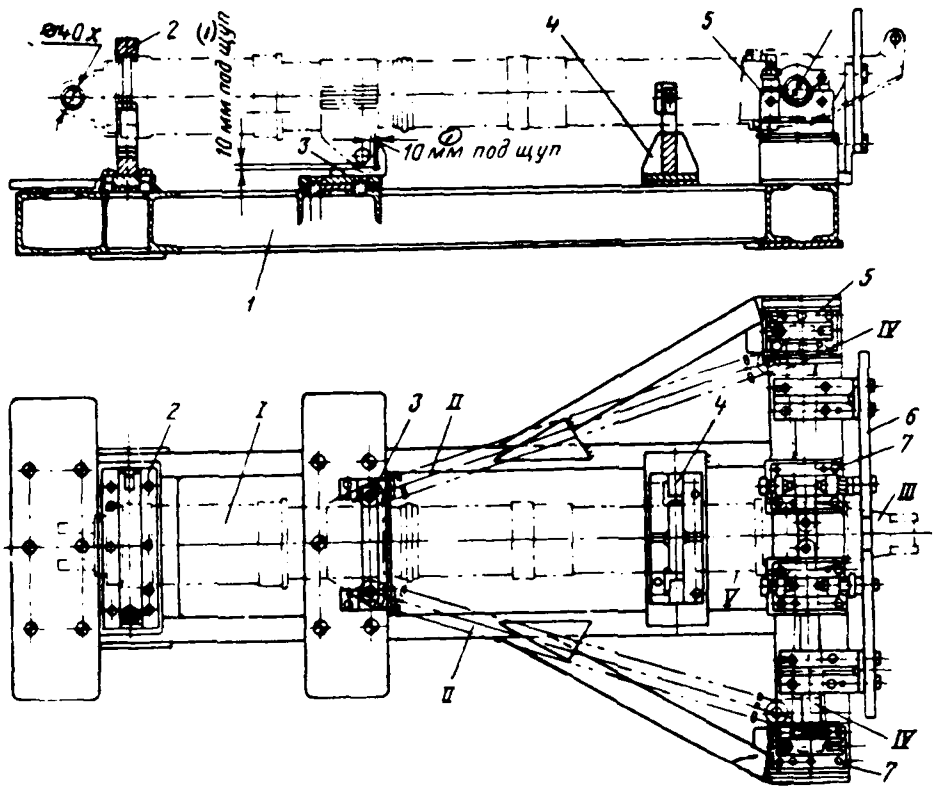

Fig. 24.2. Device for assembly of nose wheel strut of landing gear: 1 - frame; 2, 3, 4, 5, 6, and 7 - indices.

Key: (1). under the feeler.

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Two parts in number of cases are connected by press fitting due to guaranteed interference. Depending on interference and sizes/dimensions of the combinable parts the different methods of press fitting are used. In the parts of mechanical control of the type of levers, rockers, brackets and rods (Fig. 24.3), where connections on the bearings widely are used, external raceway is pressed with the aid of the mechanical, pneumatic and hydraulic

presses.

Fig. 24.4 gives pneumatic press. Stock/rod 1, equipped with socket 2 for the attachment of mounts/mandrels, is moved together with piston in cylinder 3. Press develops pressure to 900 kgf.

Application of attachments makes it possible to press bearings and bushings without presses. Fig. 24.5 gives an example of this device. Bushing 5 is centered on mount/mandrel 3 and is pressed by the impacts/shocks of hammer on insert/bushing 4 into gear 6. This device can be used also for the press fitting on the press. But most productive is the method of the press fitting of mating parts by their heating or cooling. This method consists in the use of expansion or compression of part with a change in the temperature, which makes it possible to attain a change in diametral setting sizes/dimensions of one or both combinable parts simultaneously.

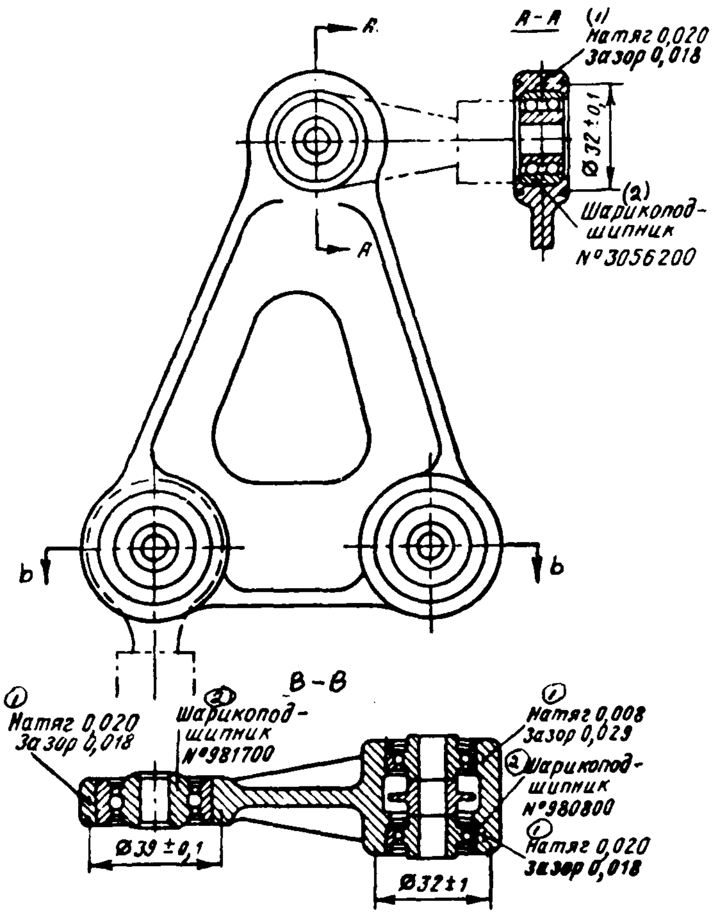

Fig. 24.3. Rocker of control system of aircraft.

Key: (1). Interference ... clearance .... (2). Ball bearing.

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As a result of this is created the necessary clearance at the moment of the connection of parts, which is selected after equalizing of temperature, and in the connection the required interference will be obtained.

For obtaining clearance z with assigned magnitude of interference

t must be observed following condition:

$$i < k_a(t_0 - t)D,$$

where k_a - coefficient of linear expansion of material during heating or cooling;

t_0 - temperature of heating or cooling part;

t - temperature of part to its heating or cooling;

D - mating dimensions of part.

To heat comparatively small according to sizes/dimensions of part of type of bearings is possible in hot oil. Temperature of heating oil on 15-20° lower than temperature of its flash/burst. Special electrical heaters and gas burners are used during heating of large parts. To cool parts is possible in the different media: dry ice (carbonic acid) makes it possible to lower temperature to -75°C, ammonia to -120°C, liquified air, oxygen or nitrogen from -180 to -190°C. Parts for the cooling are established/installed in the coolers or the thermostats.

During fitting/landing with large interference of cooling or heating by one of parts it proves to be insufficiently. In this case they resort to the combination of heating and cooling: internal member is cooled, and that encompassing - is heated. For example, they provide the required interference with the assembly of lever 1 with the axle of wheel and nose wheel strut of landing gear of aircraft with this method (Fig. 24.6). Lever is heated to 180-200°C, and axis/axle is cooled to -45-50°C.

With dismantling of connections, carried out by method of press fitting, mechanical and hydraulic strippers are used. One should remember that during the decompression, as a rule, are damaged the surfaces of mating parts. This depresses strength of press connection, if parts repeatedly are pressed.

Sometimes dismantling of press connection leads to destruction by one of combinable parts; therefore it follows to avoid it.

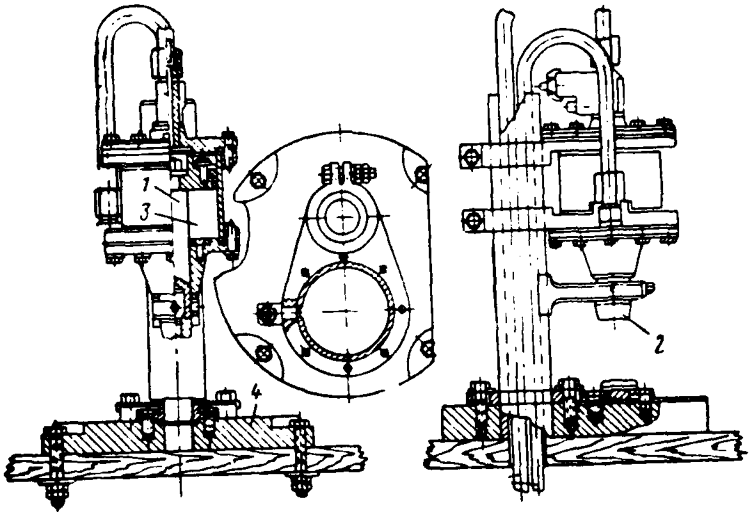

Fig. 24.4. Bench pneumatic press: 1 - stock/rod; 2 - socket; 3 - cylinder; 4 - base/root.

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Besides forms of connections given above, with assembly of assemblies of machinery are used riveting, welding, cementing, soldering, etc. Technology of accomplishing of these forms of connections is in detail examined in the preceding/previous chapters of course.

Control of mechanisms by application in constructions of assemblies of mobile and fixed compensators compose integral part of assembly (see Chapter XXI).

As example it is possible to give control of tightening of roller bearing with the aid of packing (Fig. 24.7a). To shortcomings in this

method should be related the need for the preliminary assembly of unit for determining the value of actual clearance, and then follows its dismantling, also, after setting of packing - repeated assembly.

Mobile compensators are more rational. Fig. 24.7b shows the application of a threaded compensator for regulating end play of bevel gearing of reducer. However, a similar threaded compensator is used in the adjustable rigid rod/thrust of the system of controls by aircraft (Fig. 24c). Size/dimension L between the centers of the holes of forks/branchings can be changed with screwing up or unscrewing of fork/branching 1 along the thread of sleeve/beaker 2. The precision/accuracy of size control ΔL is equal to half of pitch of thread. For regulating the angle φ during the installation of rocker 1 to shaft 2 (Fig. 24d) is used slot compensator 3. The precision/accuracy of control is determined by the value of the angular pitch $\Delta\varphi$ of slot compensator.

As example of similar control can serve assembly of screw mechanism of flap control of aircraft Il-18 (Fig. 24.8). Screw mechanism - most complicated assembly of the system of the flap control. It consists of screw 8 and nut 7 with the special shape of thread for the balls/spheres.

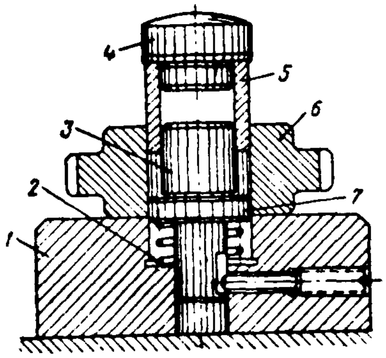

Fig. 24.5. Device for press fitting of bushings: 1 - base/root; 2 - spring; 3 - mount/mandrel; 4 - insert/bushing; 5 - bushing; 6 - gear; 7 - plunger.

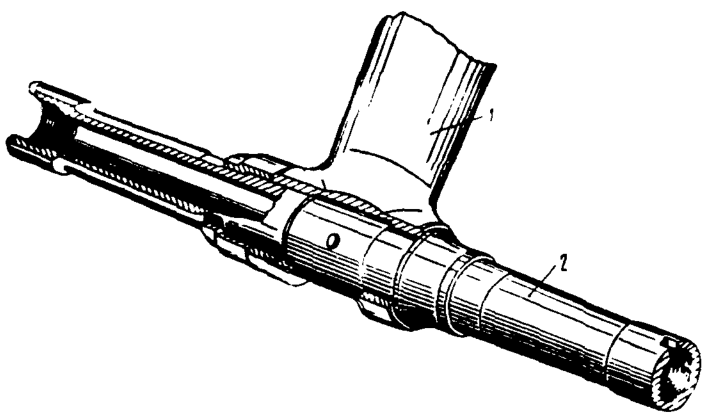

Fig. 24.6. Connection of lever with axle of wheel of nose wheel strut of landing gear of aircraft 1 - lever; 2 - wheel axle.

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Nut 7 is fastened with ears to pin 9, established/installed in the supporting unit of 10 flaps. Into the assembly of screw mechanism enters the series/row of other parts.

In shaped grooves of thread of screw and nut are placed balls/spheres 6, which during rotation of screw are rolled along grooves, replacing *sliding friction by rolling friction in screw pair.* Internal face of nut 7 limits lead 8 with its screwing up into the nut, and external end/face 11 - with the unscrewing. After the balls/spheres will pass the assumed quantity of turns with the aid of the special tooth - the cut-off of nut, they leave along the bypass channel of nut again for the groove of thread. Screw 8 obtains rotation from the shaft of transmission 1 through gear reducer 2.

Assembly of screw mechanism is fulfilled in following order. Nut 7 is assembled with screw 8, balls/spheres 6 and all other parts. Channels in internal and external detents of nut are together sawn for the guarantees of light, without the assignments of the outlet of balls/spheres into the closing channel of nut and is checked the ease/lightness of the rotation of nut in the screw.

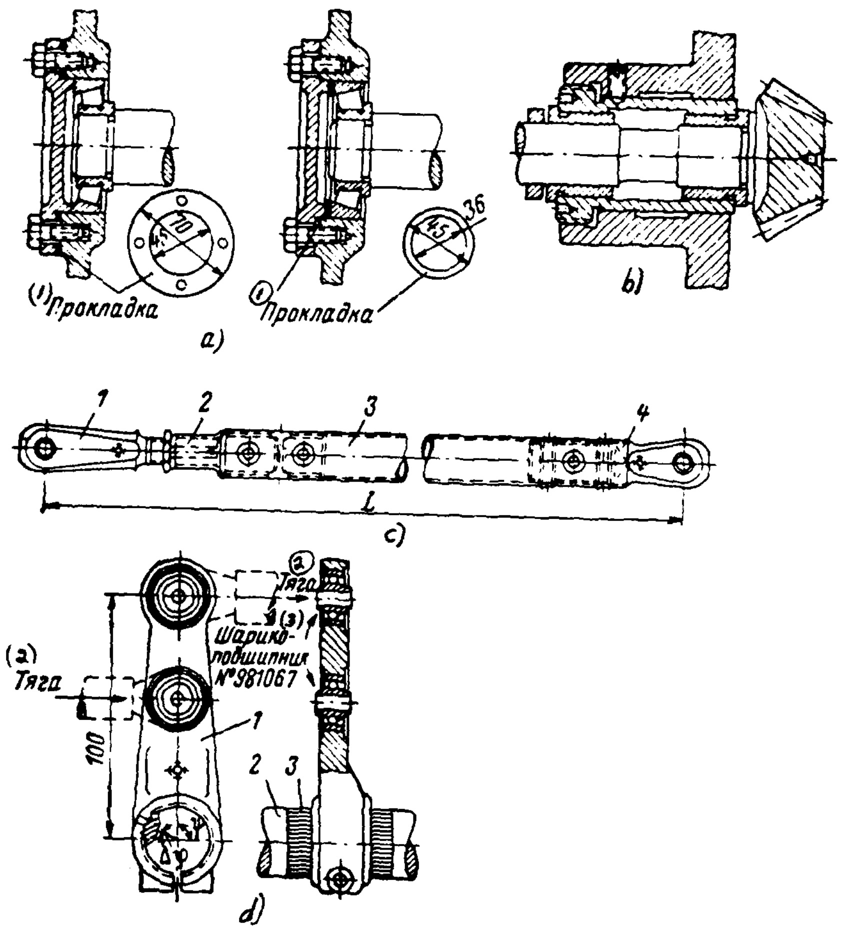

Fig. 24.7. Compensators, used in assemblies and units of machinery: a) compensator-packing; b) threaded compensator in bevel gearing; c) threaded compensator in controllable thrust of control system of aircraft (1 - fork/branching with thread, 2 - sleeve/beaker, 3 - tube/pipe, 4 - forked sleeve/beaker). d) slot compensator (1 - rocker, 2 - shaft, 3 - slot compensator).

Key: (1). Packing. (2). Rod. (3). Ball bearing.

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In the vertical position of screw the nut must evenly be screwed under

the dead weight. Screw mechanism is dismantled after this, and parts completely/unitized are marked. The bushings of the front/leading and back stops of nut and internal tooth-cut-off are surrendered to the cadmium plating, and nuts - for the nitriding, after which they undergo magnetic crack detection.

Screw mechanism reassemble at termination of operations above parts indicated and are checked: outlet of balls/spheres into closing channel (it must be free without jammings with screwing of nut from screw under dead weight), end play of nut on screw (not more than 0.5 mm) and radial clearance (0.15-0.22 mm), conformity of working stroke of nut on screw by data of drawing. In conclusion mechanism they maintain in heat chamber 8 hour at a temperature -60°C and then the ease/lightness of the screwing of nut from the screw again is checked. If testing screw mechanism satisfies the established/installed requirements, it are tested to failure-free performance in the work on special stand.

§3. Adjustment, testing and the control of the assemblies of machinery.

Quality of both separate units in process of assembly of assembly and whole assemblies after their assembly is checked for reliability of action of assemblies of machinery of aircraft under operating conditions. Tests are necessary even with complete interchangeability of parts.

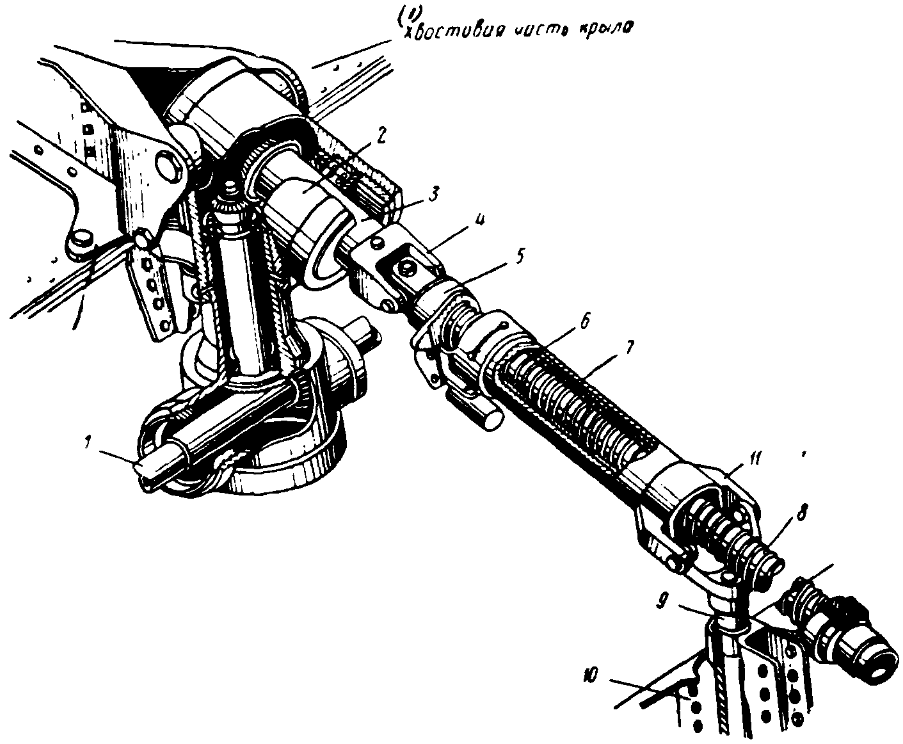

Fig. 24.8. Screw mechanism of flap control of aircraft Il-18: 1 - shaft of transmission; 2 - reducer; 3 - output shaft of reducer; 4 - universal joint; 5 - detent; 6 - balls/spheres; 7 - nut-slider; 8 - screw; 9 - pin; 10 - supporting unit; 11 - end/face of nut.

Key: (1). tail part of the wing.

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This is caused by the fact that with the assembly appears a series of the errors, connected with elastic deformations of parts, by inaccuracies in the assembly and difficultly recovered by digressions from the established/installed assembly process.

Assemblies of machinery and entering in them units undergo

different kind tests for testing conformity of their parameters to technical specifications for strength, for service life and reliability, to correctness of action of kinematics of mechanism, on clearing time of mechanism, etc.

All power hydroaggregates and assemblies pneumo- and of hydraulic systems test, first of all, to strength and airtightness. As an example let us examine the process of testing for strength (pressing) of the shock absorber of the nose wheel strut of chassis/landing gear (Fig. 24.9). Shock absorber is maintained/withstood under hydraulic pressure of liquid AMG-10, equal to 200% of maximum calculated, during 3 min. For the safety to the period of tests the shock absorber is established/installed in the special shielded chamber. Endurance test for strength during 3 days under the pressure is the second stage.

To airtightness test valve of diffuser and sealings/packings of upper and lower covers/caps of diffuser and stock/rod of shock absorber under pressure of nitrogen or air 60 kgf/cm^2 during 7 hour, also, after decompression to 17 kgf/cm^2 during 2 more hour. The leak of nitrogen or air is not allowed/assumed. Furthermore, sealings/packings of upper and lower covers/caps test to the airtightness at minus temperature (-55°C). This type of tests passes selectively one shock absorber of the batch and only in the case of the unsatisfactory results of tests - entire batch.

Shock absorbers, tested to strength and airtightness, are

dismantled, all their parts undergo inspection and magnetic crack detection, they reassemble finally after which. The latter is testing for airtightness of sealings/packings in the oil bath at normal and minus temperature (-55°C). The careful tests of shock absorbers guarantee the reliable and failure-free work of landing gear of aircraft under the operating conditions.

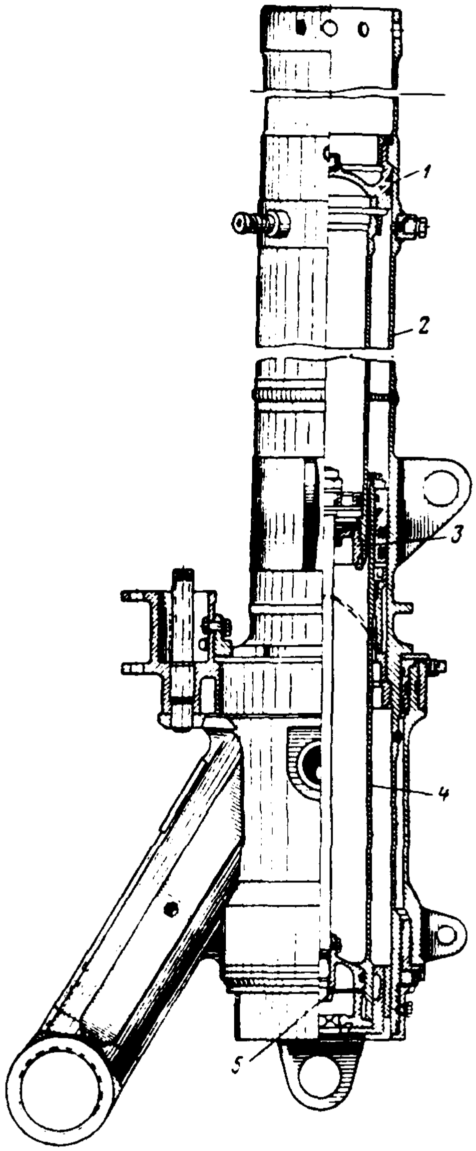

Fig. 24.9. Shock absorber of nose wheel strut of landing gear of aircraft Il-18: 1 - upper base; 2 - cylinder of shock absorber; 3 - diffuser; 4 - stock/rod of shock absorber; 5 - lower base.

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Separate assemblies pass special types of tests. For example, in

the shock struts it is checked the friction of piston packings and upper journal box, and also initial and final efforts/forces with the operating loads.

Assembled assemblies are checked against correctness of their action in accordance with technical specifications. For example, the aircocks of control of assemblies - to the functioning with respect their work in the system, the completely assembled assemblies of chassis/landing gear - to the correctness of the action of kinematics during landing gear lowering and retracting under the conditions, which imitate flight conditions and, etc.

Fig. 24.10 depicts schematic of stand for adjustment of kinematics of main landing gear of aircraft. Landing gear is established/installed on the stand in the assembly with the flaps of hatch. Aerodynamic drag with retraction and intake of landing gear strut is imitated by load 13, connected through the system of rollers 11 and the cable with the wheel axle. On the stand is checked the evenness of the course by landing gear during the retraction and the lowering, the conformity of the effort/force of retraction and issue to calculated effort/force, the timing of the work of landing gear and flaps of hatch, is measured the time of retraction and landing gear lowering. For determining the time of retraction and landing gear lowering to the control panel 1 the signals with the aid of limit switches 7 and 9, established/installed on the locks of retracted position 8 and released position 10 are supplied. The points of

attachment by landing gear and locks on the stand are set to the same mock-up of landing gear, which is utilized with the assembly of the assembly of aircraft for the installation of analogous units.

Tests for reliability of assembly present special form (training). Such tests, for example, with the screw mechanisms of the flap control of aircraft Il-18 (see Fig. 24.8) are fulfilled on the special stand (Fig. 24.11) under the conditions, close to the flight, i.e., with the operating loads and temperatures.

With the aid of reversal of electric motor 3, connected with screw/propeller of 4 screw mechanisms through system of wedge-shaped belt drive and special universal joint 2 being tested, nut of screw mechanism 7 accomplishes reciprocating motion. The course of nut is regulated by the position of limit switches 5 and 6, which control switching electric motor to the straight/direct and back stroke. Axial loads on the screw/propeller are created a pressure of air in pneumatic cylinder 8. The pressure in the cylinder, which corresponds to minimum and peak loads on the screw mechanism, is checked by manometer 9. For the measurement of moment/torque on drive shaft of screw mechanism the stand is equipped with loads 10, which are moved on rack 12, mounted to drive shaft 11 and calibrated to the value of the moments/torques, which correspond to minimum and maximum pressure in cylinder 8.

At first mechanism is rolled with minimum load, during 50 cycles

(double strokes), after which, without removing/taking basic load, is checked value of moment/torque of moving of mechanism in three positions of nut on screw/propeller: in the beginning, at the end and mid-position. If for this axial load moment/torque exceeds calculated value, are repeated rolling and tests for moment/torque of moving. If repeated rolling does not lead to the required results, screw mechanism is rejected. With the satisfactory results further tests are conducted with the maximum axial load. They give 25 cycles to mechanism and again is measured the moment/torque of moving. In conclusion is checked the action of mechanism on the moment/torque of moving at a temperature -60°C.

At termination of all tests screw mechanism they dismantle and check state of spiral paths/tracks of screw and nut, on surfaces of which there must not be impressions of balls/spheres.

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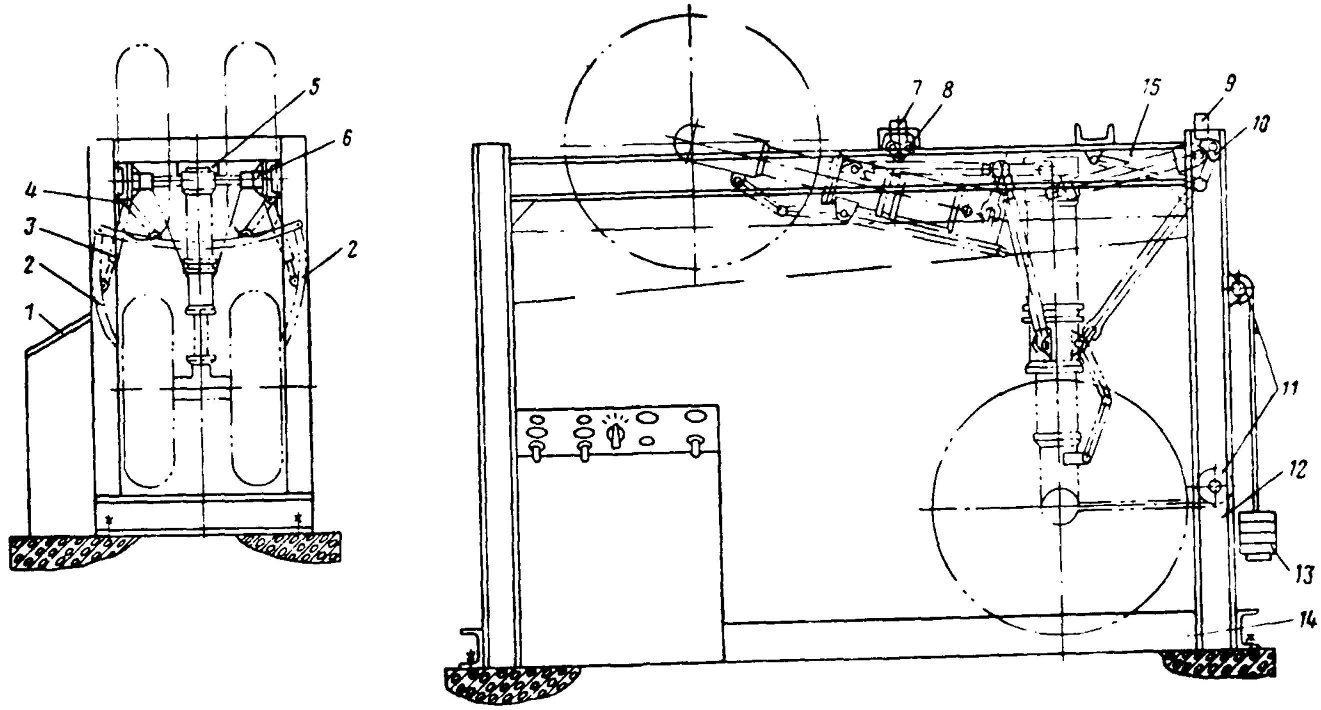

Fig. 24.10. Stand of adjustment of kinematics of main landing gear: 1 - control panel; 2 - flap of hatch; 3 - hydraulic cylinder of flaps; 4 - unit of suspension of flaps; 5, 6 - units of suspension of landing gear; 7, 8 - lock of gear up position with limit switch; 9, 10 - lock of gear down position with limit switch; 11 - guide pulleys of cable; 12 - strut; 13 - load; 14 - base/root of stand; 15 - stringer of framework/body of stand.

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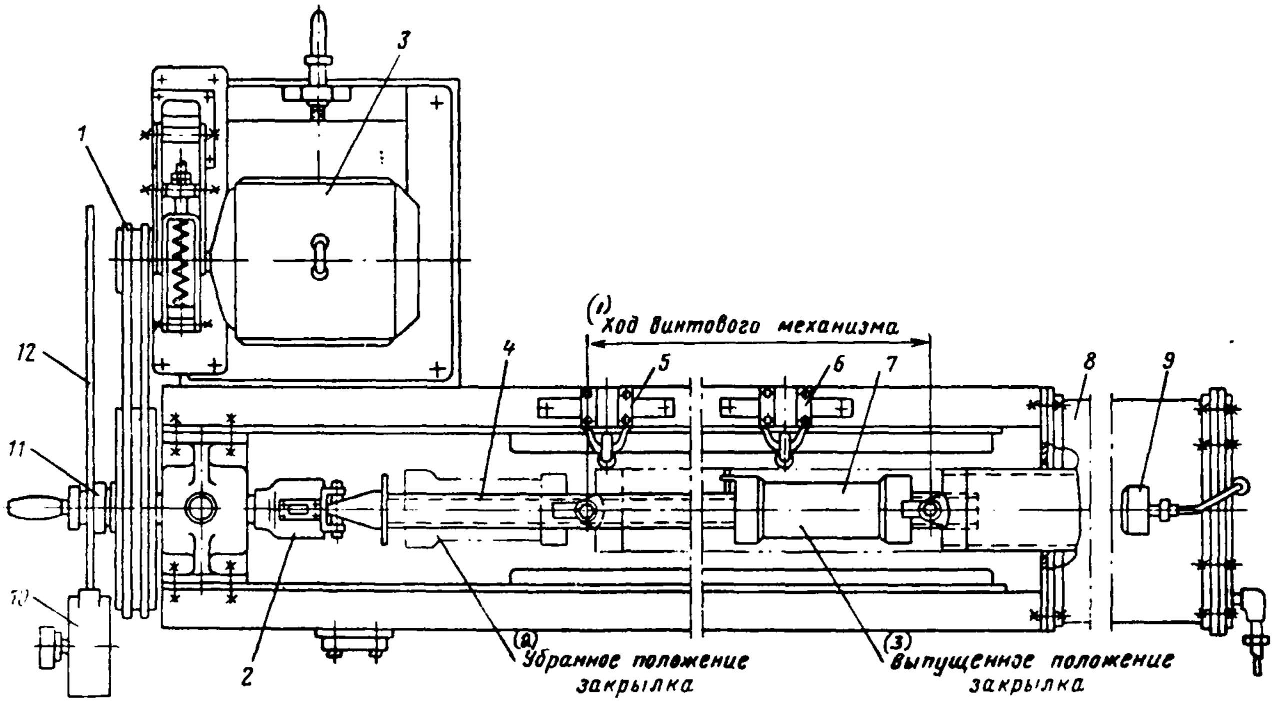

Fig. 24.11. Run-in table and testing screw mechanism of flap control: 1 - belt drive; 2 - universal joint; 3 - electric motor; 4 - screw; 5 and 6 - limit switches; 7 - screw mechanism; 8 -pneumatic cylinder; 9 - manometer; 10 - loads; 11 - drive shaft; 12 - rack.

Key: (1). Course of screw mechanism. (2). Flaps up position. (3). Flaps down.

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Screw, nut and balls/spheres are subjected to magnetic crack detection, after which again they assemble screw mechanism, check the ease/lightness of the screwing of nut from the screw under the dead weight, the axial and radial gap of nut on the screw measures on the stand the moment/torque of the moving of screw without the load.

Screw mechanisms, which correspond to established/installed requirements, are transferred for installation to aircraft.

S4. Methods and the means of the guarantee of interchangeability during the installation of the assemblies of machinery.

Assemblies and units of machinery to aircraft must be established/installed without adjustments and modifications of places of their fastening. For guaranteeing the interchangeability during the installation of the systems of mechanical equipment on different stages of the assembly of the airframe of aircraft is fulfilled the work on the preparation of the places of fastening brackets under units and assemblies of these systems.

In blank production shops in walls of frames/formers, ribs, beams and diaphragms under cable guide and rigid control rods of aircraft are fulfilled holes according to appropriate templates/patterns. Subsequently with the assembly of frames/formers, ribs, beams and diaphragms the parts with the holes are set to indices with the base to the holes indicated and the contour/outline of the aircraft.

Holes for fastening of flanged fittings, brackets under rockers and assemblies of machinery are bored in walls of frames/formers, on floor of cockpit and other elements of construction of airframe along jigs of assembly jigs with their assembly.

Brackets, assemblies and assemblies of machinery, whose assembly bases are connected with basic aircraft bases - horizontal datum line and plane of symmetry of aircraft, are established/installed with assembly of sections and assemblies of machinery. Let us examine this based on the example of the installation of the main landing gear of aircraft in the detachable wing section (Fig. 24.12).

Units of suspension of traverse 1, lock of gear up position 2, hydraulic power cylinder of lift and production of strut of landing gear 3 and rear landing gear strut 4 are established/installed to elements of construction of detachable wing section 8 on mock-up of landing gear, which accurately reproduces arrangement/position of all units indicated. The mock-up of landing gear is based on the special reference areas/sites 5 and 6 of assembly jig 7. For ease of assembly and removal of OChK from assembly jig the standard of landing gear is projected/designed with removable on the split plane n-n.

For guaranteeing interchangeability during installa of landing gear its standard is taken apart and is checked i. ss of operation using instrument/tool standard of well of landing r OChK, which imitates well of landing gear of wing with all units of suspension and fastening of its elements. The units of suspension and landing gear attachment on the stand of the adjustment of its kinematics (see Fig. 24.10) also are advanced on the mock-up of landing gear.

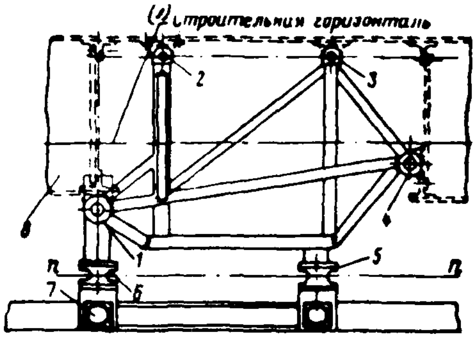

Fig. 24.12. Mock-up of main landing gear of aircraft.

Key: (1). Structural horizontal.

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